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Liquid Piston with Phase Change to Absorb Thermal Transients

p.69-70 (2)

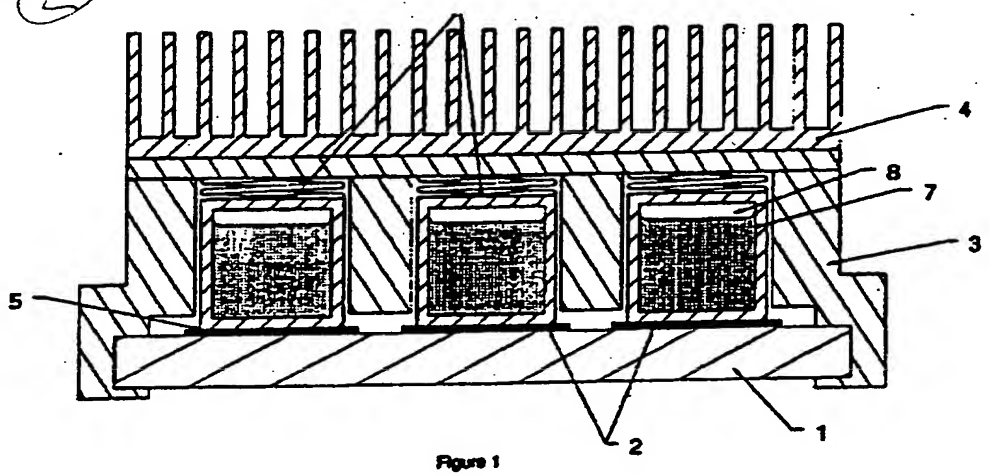

Figure 1

A method of controlling, or at least reducing, the temperature fluctuation of CMOS chips caused by the power fluctuation inherent in CMOS circuitry is disclosed. A phase-change material chosen for its melting temperature is placed in close contact with the CMOS chips in a SCM or MCM package.

This invention discloses a method of controlling or reducing the temperature fluctuations, and therefore the thermally induced stresses in the C4 balls, of CMOS chips undergoing power fluctuations. The idea is to provide a very large thermal capacity that is thermally in close proximity to the chip surface (therefore very close to the C4s). The concept is presented in Figs. 1 and 2. The simplest design is presented in Fig. 1. A multi-chip substrate (1) is populated with CMOS chips (2). The substrate and chips are enclosed within a metal housing (3). The housing has provisions for attaching a heat sink (4) so that the power dissipated by the chips can be easily transferred to a cooling air stream. A thermal grease (or oil) layer (5) between the chips and the piston provides a low resistance thermal path. Within the module the normal solid (copper or aluminum) pistons are replaced by hollowed, spring-loaded pistons (6) filled with an appropriate material (7) which can undergo a solid-liquid phase change. The gap (8) at the top of the piston is filled with a gas - a compressible media to allow for the volume change of the material as it changes phase.

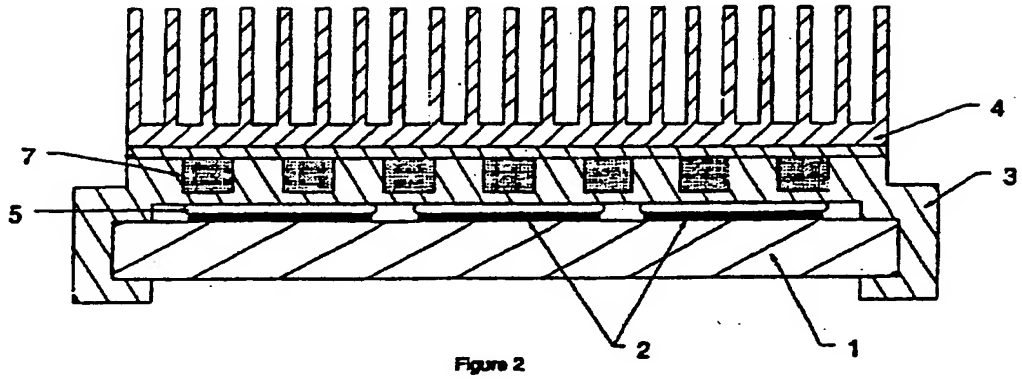

Figure 2

Fig. 2 presents an alternate design. In this design, the module housing contains the phase change material. No pistons are used. The resulting heat path is from the chip through the grease (or other interface material), into the housing and through the phase change material. The effect will be the same as the piston approach, as long as the grease interface is thin enough.

There are many methods of keeping the phase change material in close proximity to the chips. The cap can be made with a matrix of pockets to receive the material, then sealed with a thin metal cover. Another option is to make the cap from a porous material with the interstitial volume filled with the phase change material. This application of phase change material for controlling temperature fluctuations is applicable to single chip modules as well as multiple chip modules.